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(54) **WATER HEATER APPLIANCE AND A METHOD FOR OPERATING THE SAME**

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F24H 1/20	(2006.01)
F24H 9/12	(2006.01)
F24H 9/20	(2006.01)

(52) **U.S. Cl.**

CPC ***G05D 23/1366*** (2013.01); ***F24H 1/202*** (2013.01); ***F24H 9/124*** (2013.01); ***F24H 9/2021*** (2013.01); *Y10T 137/6416* (2015.04)

(58) **Field of Classification Search**

CPC G05D 11/16; G05D 23/1858; G05D 23/1353; F24D 19/1051; F24D 19/1015

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See application file for complete search history.

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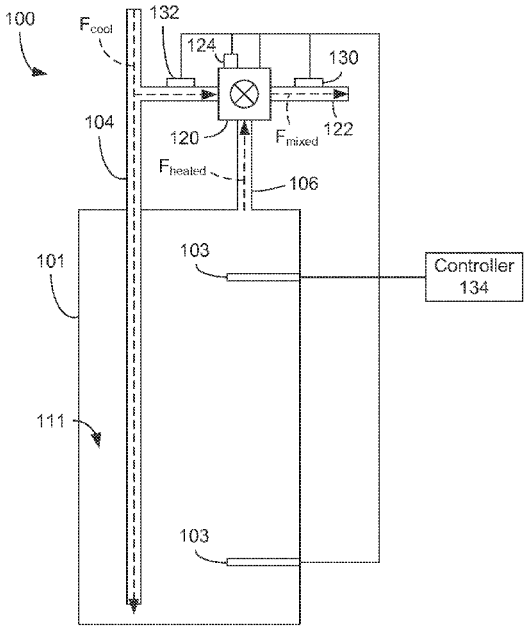
(57) **ABSTRACT**

A water heater appliance and a method for operating the same are provided. The method includes receiving a first temperature measurement from a temperature sensor of the water heater appliance, receiving a second temperature measurement from the temperature sensor of the water heater appliance, and establishing if water is flowing through a conduit of the water heater appliance based at least in part on the first and second temperature measurements.

10 Claims, 5 Drawing Sheets



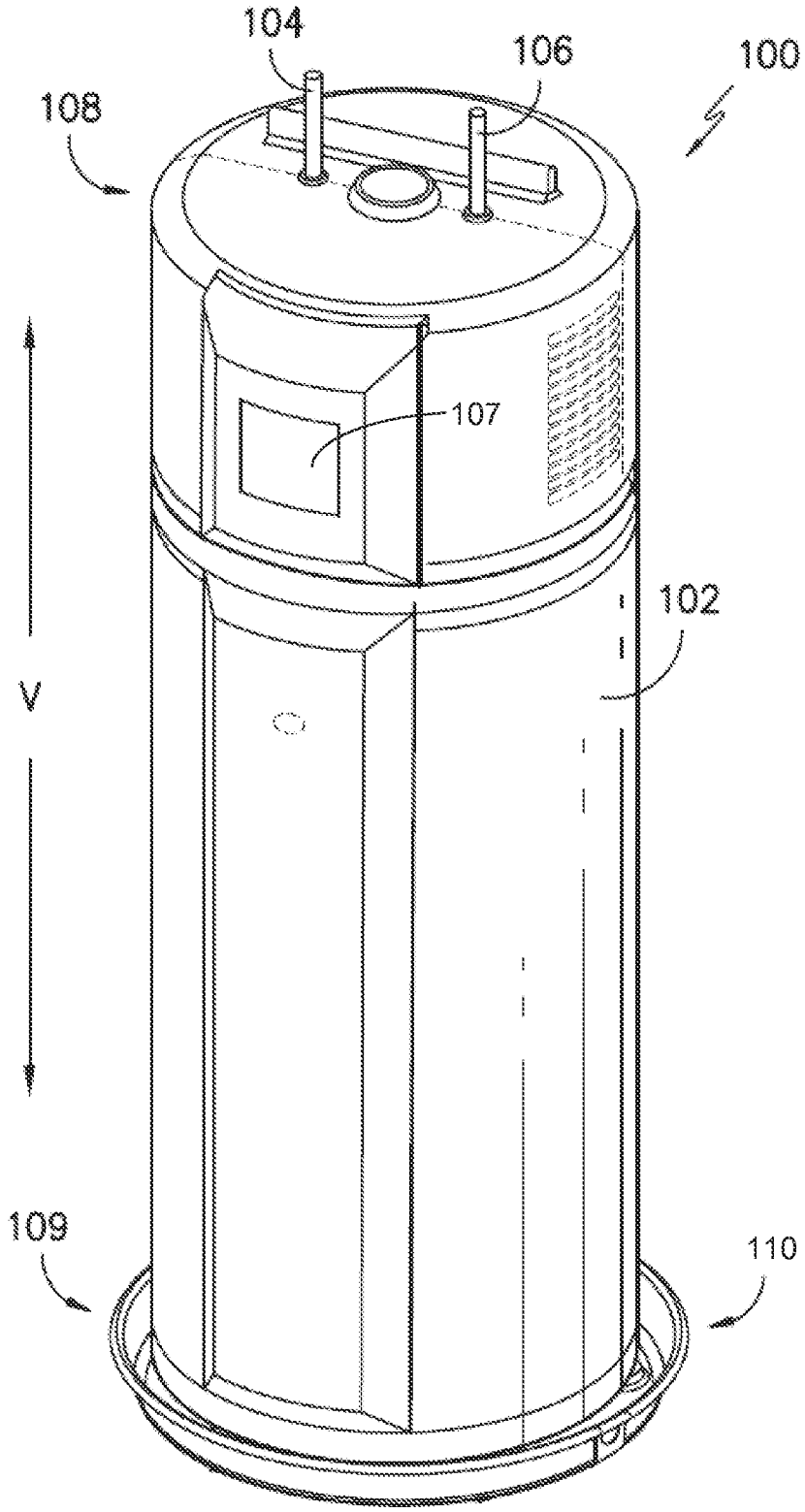


FIG. 1

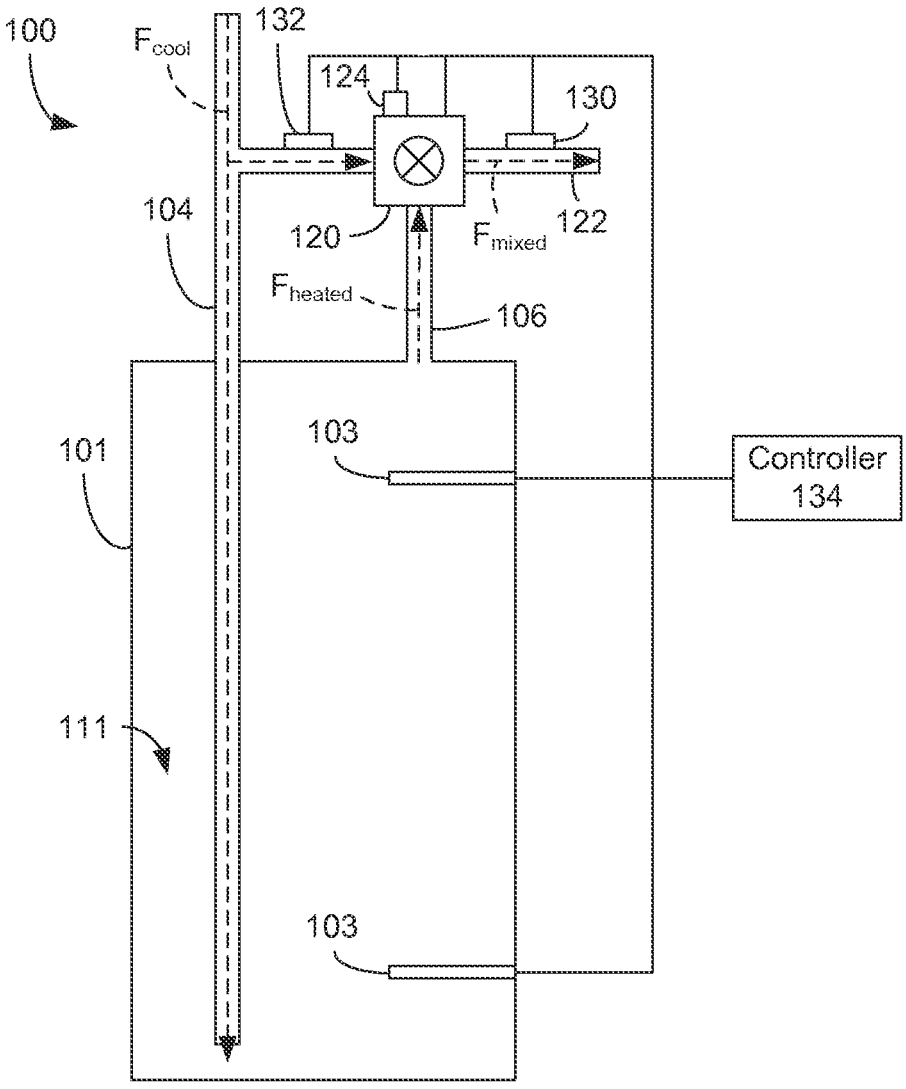

100
F_{cool}
132
124
130
104
120
F_{mixed}
122
F_{heated}
106
101
103
Controller
134
111
103

FIG. 2

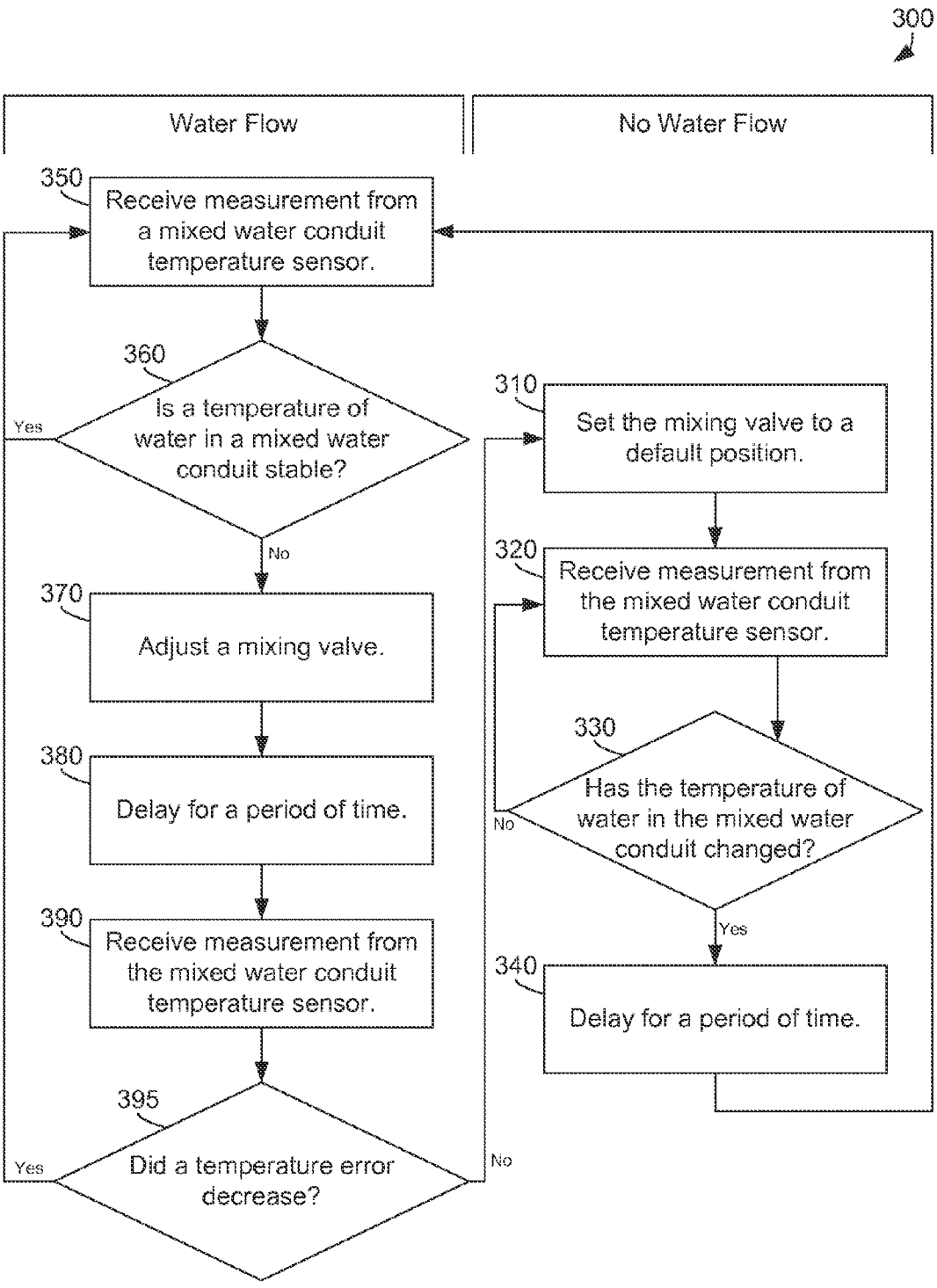

300
Water Flow
No Water Flow
350
Receive measurement from a mixed water conduit temperature sensor.
360
Is a temperature of water in a mixed water conduit stable?
Yes
No
370
Adjust a mixing valve.
380
Delay for a period of time.
390
Receive measurement from the mixed water conduit temperature sensor.
395
Did a temperature error decrease?
Yes
No
310
Set the mixing valve to a default position.
320
Receive measurement from the mixed water conduit temperature sensor.
330
Has the temperature of water in the mixed water conduit changed?
No
Yes
340
Delay for a period of time.

FIG. 3

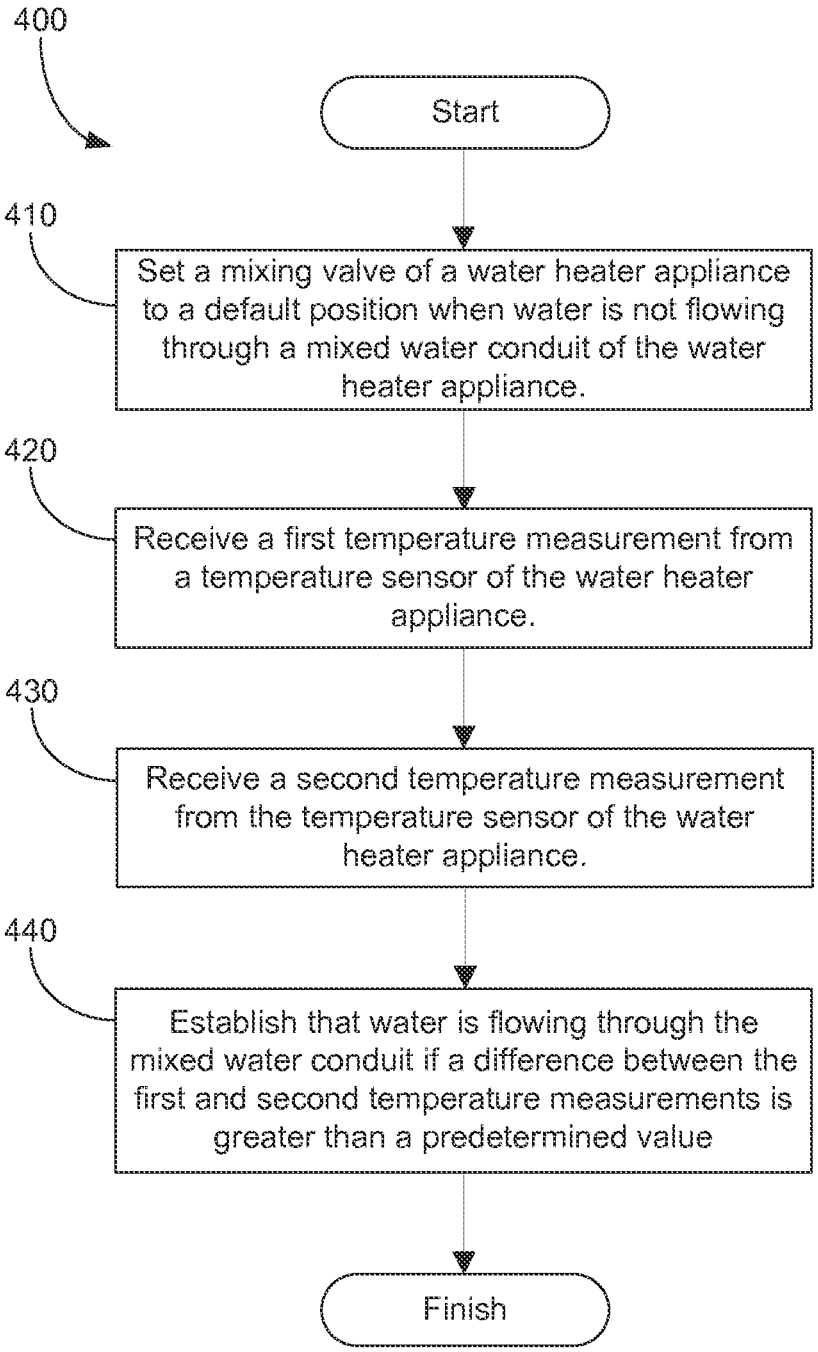

400
Start
410
Set a mixing valve of a water heater appliance to a default position when water is not flowing through a mixed water conduit of the water heater appliance.
420
Receive a first temperature measurement from a temperature sensor of the water heater appliance.
430
Receive a second temperature measurement from the temperature sensor of the water heater appliance.
440
Establish that water is flowing through the mixed water conduit if a difference between the first and second temperature measurements is greater than a predetermined value
Finish

FIG. 4

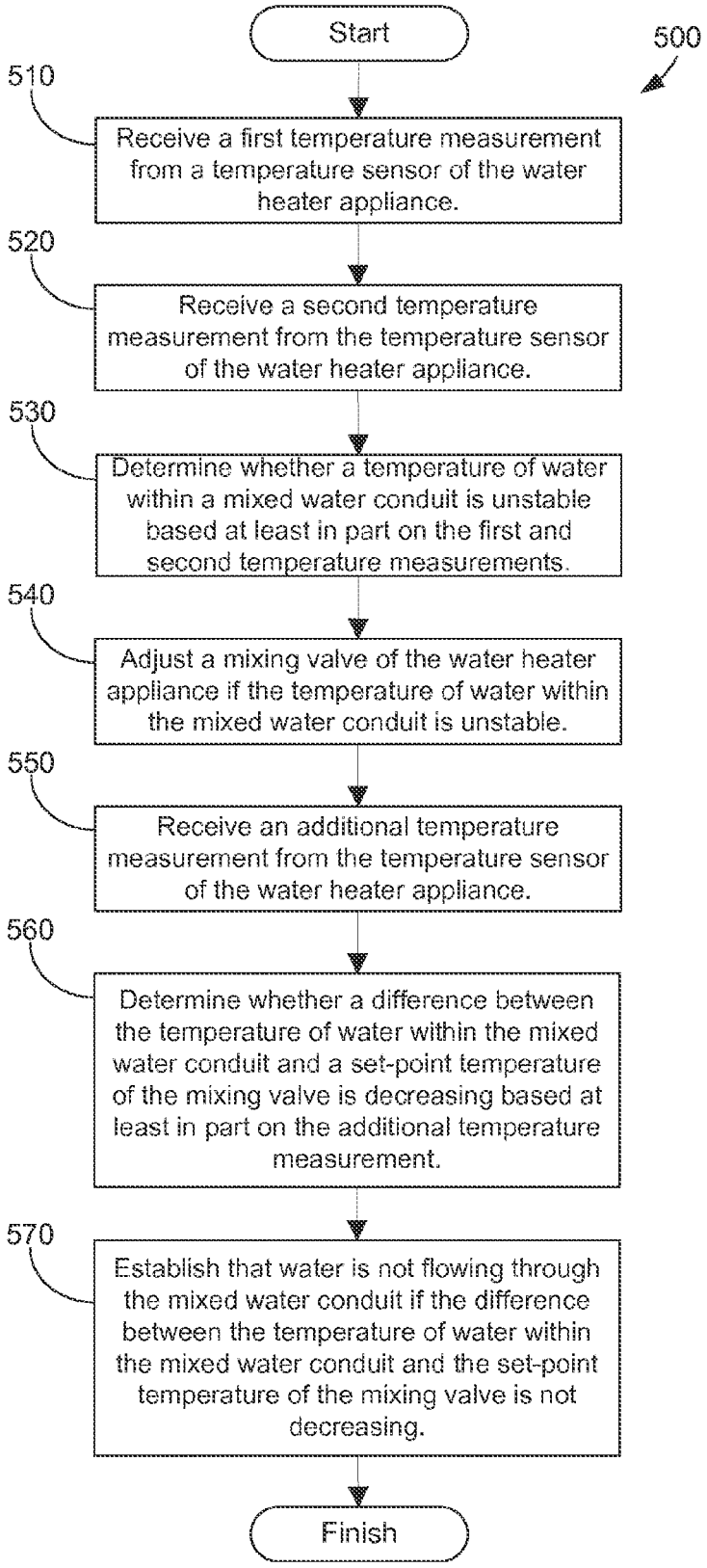

Start
500
510
Receive a first temperature measurement from a temperature sensor of the water heater appliance.
520
Receive a second temperature measurement from the temperature sensor of the water heater appliance.
530
Determine whether a temperature of water within a mixed water conduit is unstable based at least in part on the first and second temperature measurements.
540
Adjust a mixing valve of the water heater appliance if the temperature of water within the mixed water conduit is unstable.
550
Receive an additional temperature measurement from the temperature sensor of the water heater appliance.
560
Determine whether a difference between the temperature of water within the mixed water conduit and a set-point temperature of the mixing valve is decreasing based at least in part on the additional temperature measurement.
570
Establish that water is not flowing through the mixed water conduit if the difference between the temperature of water within the mixed water conduit and the set-point temperature of the mixing valve is not decreasing.
Finish

FIG. 5

WATER HEATER APPLIANCE AND A METHOD FOR OPERATING THE SAME

FIELD OF THE INVENTION

The present subject matter relates generally to water heater appliance and methods for operating the same.

BACKGROUND OF THE INVENTION

Certain water heater appliances include a tank therein. Heating elements, such as gas burners, electric resistance elements, or induction elements, heat water within the tank during operation of such water heater appliances. In particular, the heating elements generally heat water within the tank to a predetermined temperature. The predetermined temperature is generally selected such that heated water within the tank is suitable for showering, washing hands, etc.

During operation, relatively cool water flows into the tank, and the heating elements operate to heat such water to the predetermined temperature. Thus, the volume of heated water available at the predetermined temperature is generally limited to the volume of the tank. According, water heater appliances are sold in various sizes to permit consumers to select a proper tank volume and provide sufficient heated water. However, large water heater appliances with large tanks occupy large amount of space within a residence or business. In certain buildings, space is limited and/or expensive. Thus, utilizing large water heater appliances can be impractical and/or prohibitively expensive despite needing large volumes of heated water.

To provide relatively large volumes of heated water from relatively small tanks, certain water heater appliances utilize a mixing valve. The mixing valve permits water within the water heater's tank to be stored at relatively high temperatures. The mixing valve mixes such high temperature water with relatively cool water in order to bring the temperature of such water down to suitable and/or more usable temperatures. Thus, such water heater appliance can provide relatively large volumes of heated water without requiring large tanks.

To operate efficiently, water heater appliances with mixing valves generally determine whether hot water is in demand or is flowing. When water is flowing through the mixing valve, the mixing valve adjusts the ratio of relatively hot water and relatively cold water in order to control the temperature of water supplied downstream. Certain water heater appliances utilize a flowmeter or a flow sensor to determine if water is flowing through the mixing valve, but such devices can be unreliable. In particular, flowmeters and flow sensors include moving components that can clog or otherwise malfunction due to hard water or debris.

Accordingly, a water heater appliance having a mixing valve that includes features for determining when water is flowing through the mixing valve would be useful. In particular, a water heater appliance having a mixing valve that includes features for determining when water is flowing through the mixing valve without using a flowmeter or a flow sensor would be useful.

BRIEF DESCRIPTION OF THE INVENTION

The present subject matter provides a water heater appliance and a method for operating the same. The method includes receiving a first temperature measurement from a temperature sensor of the water heater appliance, receiving a second temperature measurement from the temperature sensor of the water heater appliance, and establishing if water is flowing through a conduit of the water heater appliance based at least in part on the first and second temperature measurements. Additional aspects and advantages of the invention will be set forth in part in the following description, or may be apparent from the description, or may be learned through practice of the invention.

In a first exemplary embodiment, a method for operating a water heater appliance is provided. The water heater appliance has a tank and a heating element for heating water within the tank. The water heater appliance also has a cold water conduit for directing a flow of water into the tank and a hot water conduit for directing water out of the tank. The water heater appliance further has a mixing valve. The mixing valve is configured for regulating a temperature of water within the hot water conduit by selectively directing a flow of relatively cool water into the hot water conduit. The water heater appliance also has a temperature sensor positioned downstream of the mixing valve for measuring a temperature of water within the hot water conduit. The method includes setting the mixing valve of the water heater appliance to a default position when water is not flowing through the hot water conduit of the water heater appliance, receiving a first temperature measurement from the temperature sensor of the water heater appliance, receiving a second temperature measurement from the temperature sensor of the water heater appliance after the step of receiving the first temperature measurement, determining whether a rate of change of the temperature of water within the hot water conduit is greater than a predetermined value based at least in part on the first and second temperature measurements, and establishing that water is flowing through the hot water conduit of the water heater appliance if the rate of change of the temperature of water within the hot water conduit is greater than the predetermined value at the step of determining whether the rate of change of the temperature of water within the hot water conduit is greater than the predetermined value.

In a second exemplary embodiment, a water heater appliance is provided. The water heater appliance includes a tank that defines a chamber and a heating element for heating water within the chamber of the tank. A cold water conduit is in fluid communication with the chamber of the tank. The cold water conduit is configured for directing a flow of water into the chamber of the tank. A hot water conduit is in fluid communication with the chamber of the tank. The hot water conduit is configured for directing a flow of water out of the chamber of the tank. The water heater appliance also includes a mixed water conduit. A mixing valve is in fluid communication with the hot water conduit, the cold water conduit, and the mixed water conduit. The mixing valve is configured for selectively permitting water from the cold water conduit and the hot water conduit into the mixed water conduit in order to regulate a temperature of water within the mixed water conduit. A temperature sensor is positioned proximate the mixed water conduit and downstream of the mixing valve. The temperature sensor is configured for measuring the temperature of water within the mixed water conduit. The water heater appliance further includes a controller in communication with the mixing valve and the temperature sensor. The controller is configured for setting the mixing valve to a default position when water is not flowing through the mixed water conduit, receiving a first temperature measurement from the temperature sensor, receiving a second temperature measurement from the temperature sensor after the step of receiving the first temperature measurement, and establishing that water is flowing through the mixed water conduit if a difference between the first and second temperature measurements is greater than a predetermined value.

In a third exemplary embodiment, a water heater appliance is provided. The water heater appliance includes a tank that defines a chamber and a heating element for heating water within the chamber of the tank. A cold water conduit is in fluid communication with the chamber of the tank. The cold water conduit is configured for directing a flow of water into the chamber of the tank. A hot water conduit is in fluid communication with the chamber of the tank. The hot water conduit is configured for directing a flow of water out of the chamber of the tank. The water heater appliance also includes a mixed water conduit. A mixing valve is in fluid communication with the hot water conduit, the cold water conduit, and the mixed water conduit. The mixing valve is configured for selectively permitting water from the cold water conduit and the hot water conduit into the mixed water conduit in order to regulate a temperature of water within the mixed water conduit. A temperature sensor is positioned proximate the mixed water conduit and downstream of the mixing valve. The temperature sensor is configured for measuring the temperature of water within the mixed water conduit. The water heater appliance further includes a controller in communication with the mixing valve and the temperature sensor. The controller is configured for receiving a first temperature measurement from the temperature sensor, receiving a second temperature measurement from the temperature sensor, determining whether the temperature of water within the mixed water conduit is unstable based at least in part on the first and second temperature measurements, adjusting the mixing valve if the temperature of water within the mixed water conduit is unstable at the step of determining whether the temperature of water within the mixed water conduit is unstable, receiving an additional temperature measurement from the temperature sensor after the step of adjusting the mixing valve, determining whether a difference between the temperature of water within the mixed water conduit and a set-point temperature of the mixing valve is decreasing based at least in part on the additional temperature measurement of the step of receiving the additional temperature measurement, and establishing that water is not flowing through the mixed water conduit if the difference between the temperature of water within the mixed water conduit and the set-point temperature of the mixing valve is not decreasing at the step of determining whether the difference between the temperature of water within the mixed water conduit and the set-point temperature of the mixing valve is decreasing.

These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures.

FIG. **1** provides a perspective view of a water heater appliance according to an exemplary embodiment of the present subject matter.

FIG. **2** provides a schematic view of certain components of the exemplary water heater appliance of FIG. **1**.

FIG. **3** illustrates a method for operating a water heater appliance according to an exemplary embodiment of the present subject matter.

FIG. **4** illustrates an additional method for operating a water heater appliance according to an additional exemplary embodiment of the present subject matter.

FIG. **5** illustrates another method for operating a water heater appliance according to another exemplary embodiment of the present subject matter.

DETAILED DESCRIPTION

Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

FIG. **1** provides a perspective view of a water heater appliance **100** according to an exemplary embodiment of the present subject matter. Water heater appliance **100** includes a casing **102**. A tank **101** (FIG. **2**) and heating elements **103** (FIG. **2**) are positioned within casing **102** for heating water therein. Heating elements **105** may include a gas burner, a heat pump, an electric resistance element, a microwave element, an induction element, or any other suitable heating element or combination thereof. As will be understood by those skilled in the art and as used herein, the term "water" includes purified water and solutions or mixtures containing water and, e.g., elements (such as calcium, chlorine, and fluorine), salts, bacteria, nitrates, organics, and other chemical compounds or substances.

Water heater appliance **100** also includes a cold water conduit **104** and a hot water conduit **106** that are both in fluid communication with a chamber **111** (FIG. **2**) defined by tank **101**. As an example, cold water from a water source, e.g., a municipal water supply or a well, can enter water heater appliance **100** through cold water conduit **104** (shown schematically with arrow labeled F_{cool} in FIG. **2**). From cold water conduit **104**, such cold water can enter chamber **111** of tank **101** wherein it is heated with heating elements **103** to generate heated water. Such heated water can exit water heater appliance **100** at hot water conduit **106** and, e.g., be supplied to a bath, shower, sink, or any other suitable feature.

Water heater appliance **100** extends longitudinally between a top portion **108** and a bottom portion **109** along a vertical direction V. Thus, water heater appliance **100** is generally vertically oriented. Water heater appliance **100** can be leveled, e.g., such that casing **102** is plumb in the vertical direction V, in order to facilitate proper operation of water heater appliance **100**. A drain pan **110** is positioned at bottom portion **109** of water heater appliance **100** such that water heater appliance **100** sits on drain pan **110**. Drain pan **110** sits beneath water heater appliance **100** along the vertical direction V, e.g., to collect water that leaks from water heater appliance **100** or water that condenses on an evaporator (not shown) of water heater appliance **100**. It should be understood that water heater appliance **100** is provided by way of example only and that the present subject matter may be used with any suitable water heater appliance.

FIG. **2** provides a schematic view of certain components of water heater appliance **100**. As may be seen in FIG. **2**, water heater appliance **100** includes a mixing valve **120** and a mixed

water conduit **122**. Mixing valve **120** is in fluid communication with cold water conduit **104**, hot water conduit **106**, and mixed water conduit **122**. As discussed in greater detail below, mixing valve **120** is configured for selectively directing water from cold water conduit **104** and hot water conduit **106** into mixed water conduit **122** in order to regulate a temperature of water within mixed water conduit **122**.

As an example, mixing valve **120** can selectively adjust between a first position and a second position. In the first position, mixing valve **120** can permit a first flow rate of relatively cool water from cold water conduit **104** (shown chematically with arrow labeled F_{cool} in FIG. **2**) into mixed water conduit **122** and mixing valve **120** can also permit a first flow rate of relatively hot water from hot water conduit **106** (shown schematically with arrow labeled F_{heated} in FIG. **2**) into mixed water conduit **122**. In such a manner, water within mixed water conduit **122** (shown schematically with arrow labeled F_{mixed} in FIG. **2**) can have a first particular temperature when mixing valve **120** is in the first position. Similarly, mixing valve **120** can permit a second flow rate of relatively cool water from cold water conduit **104** into mixed water conduit **122** and mixing valve **120** can also permit a second flow rate of relatively hot water from hot water conduit **106** into mixed water conduit **122** in the second position. The first and second flow rates of the relatively cool water and relatively hot water are different such that water within mixed water conduit **122** can have a second particular temperature when mixing valve **120** is in the second position. In such a manner, mixing valve **120** can regulate the temperature of water within mixed water conduit **122** and adjust the temperature of water within mixed water conduit **122** between the first and second particular temperatures.

It should be understood that, in certain exemplary embodiments, mixing valve **120** is adjustable between more positions than the first and second positions. In particular, mixing valve **120** may be adjustable between any suitable number of positions in alternative exemplary embodiments. For example, mixing valve **120** may be infinitely adjustable in order to permit fine-tuning of the temperature of water within mixed water conduit **122**.

Water heater appliance **100** also includes a position sensor **124**. Position sensor **124** is configured for determining a position of mixing valve **120**. Position sensor **124** can monitor the position of mixing valve **120** in order to assist with regulating the temperature of water within mixed water conduit **122**. For example, position sensor **124** can determine when mixing valve **120** is in the first position or the second position in order to ensure that mixing valve **120** is properly or suitably positioned depending upon the temperature of water within mixed water conduit **122** desired or selected. Thus, position sensor **124** can provide feedback regarding the status or position of mixing valve **120**.

Water heater appliance **100** also includes a mixed water conduit temperature sensor or first temperature sensor **130** and a cold water conduit temperature sensor or second temperature sensor **132**. First temperature sensor **130** is positioned on or proximate mixed water conduit **122** and is configured for measuring a temperature of water within mixed water conduit **122**. First temperature sensor **130** is also positioned downstream of mixing valve **120**. Second temperature sensor **132** is positioned on or proximate cold water conduit **104** and is configured for measuring a temperature of water within cold water conduit **104**. Second temperature sensor **132** is positioned upstream of mixing valve **120**. In certain exemplary embodiments, first temperature sensor **130** and/or second temperature sensor **132** may be positioned proximate or adjacent mixing valve **120**.

Water heater appliance **100** further includes a controller **134** that is configured for regulating operation of water heater appliance **100**. Controller **134** is in, e.g., operative, communication with heating elements **103**, mixing valve **120**, position sensor **124**, and first and second temperature sensors **130** and **132**. Thus, controller **134** can selectively activate heating elements **103** in order to heat water within chamber **102** of tank **101**. Similarly, controller **134** can selectively operate mixing valve **120** in order to adjust a position of mixing valve **120** and regulate a temperature of water within mixed water conduit **122**.

Controller **134** includes memory and one or more processing devices such as microprocessors, CPUs or the like, such as general or special purpose microprocessors operable to execute programming instructions or micro-control code associated with operation of water heater appliance **100**. The memory can represent random access memory such as DRAM, or read only memory such as ROM or FLASH. The processor executes programming instructions stored in the memory. The memory can be a separate component from the processor or can be included onboard within the processor. Alternatively, controller **134** may be constructed without using a microprocessor, e.g., using a combination of discrete analog and/or digital logic circuitry (such as switches, amplifiers, integrators, comparators, flip-flops, AND gates, and the like) to perform control functionality instead of relying upon software.

Controller **134** can be positioned at a variety of locations. In the exemplary embodiment shown in FIG. **1**, controller **134** is positioned within water heater appliance **100**, e.g., as an integral component of water heater appliance **100**. In alternative exemplary embodiments, controller **134** may be positioned away from water heater appliance **100** and communicate with water heater appliance **100** over a wireless connection or any other suitable connection, such as a wired connection.

Controller **134** can operate heating elements **103** to heat water within chamber **111** of tank **101**. As an example, a user can select or establish a set-point temperature for water within chamber **111** of tank **101**, or the set-point temperature for water within chamber **111** of tank **101** may be a default value. Based upon the set-point temperature for water within chamber **111** of tank **101**, controller **134** can selectively activate heating elements **103** in order to heat water within chamber **111** of tank **101** to the set-point temperature for water within chamber **111** of tank **101**. The set-point temperature for water within chamber **111** of tank **101** can be any suitable temperature. For example, the set-point temperature for water within chamber **111** of tank **101** may be between about one hundred and forty degrees Fahrenheit and about one hundred and eighty-degrees Fahrenheit.

Controller **134** can also operate mixing valve **120** to regulate the temperature of water within mixed water conduit **122**. For example, controller **134** can adjust the position of mixing valve **120** in order to regulate the temperature of water within mixed water conduit **122**. As an example, a user can select or establish a set-point temperature of mixing valve **120**, or the set-point temperature of mixing valve **120** may be a default value. Based upon the set-point temperature of mixing valve **120**, controller **134** can adjust the position of mixing valve **120** in order to change or tweak a ratio of relatively cool water flowing into mixed water conduit **122** from cold water conduit **104** and relatively hot water flowing into mixed water conduit **122** from hot water conduit **106**. In such a manner, controller **134** can regulate the temperature of water within mixed water conduit **122**.

The set-point temperature of mixing valve **120** can be any suitable temperature. For example, the set-point temperature of mixing valve **120** may be between about one hundred degrees Fahrenheit and about one hundred and twenty degrees Fahrenheit. In particular, the set-point temperature of mixing valve **120** may be selected such that the set-point temperature of mixing valve **120** is less than the set-point temperature for water within chamber **111** of tank **101**. In such a manner, mixing valve **120** can utilize water from cold water conduit **104** and hot water conduit **106** to regulate the temperature of water within mixed water conduit **122**.

FIG. **3** illustrates a method **300** for operating a water heater appliance according to an exemplary embodiment of the present subject matter. Method **300** can be used to operate any suitable water heater appliance. For example, method **300** may be utilized to operate water heater appliance **100** (FIG. **1**). Controller **134** of water heater appliance **100** may be programmed to implement method **300**.

Method **300** can be used to determine whether water is flowing through mixed water conduit **122**. In such a manner, method **300** can assist with operating water heater appliance **100**, e.g., by assisting operation of mixing valve **120**. In particular, knowledge of whether water is flowing through mixed water conduit **122** can assist mixing valve **120** with maintaining a proper or predetermined temperature for water within mixed water conduit **122**.

As may be seen in FIG. **3**, at step **310**, controller **134** adjusts mixing valve **120** to a default position, e.g., when water is not flowing through mixed water conduit **122**. Controller **134** can adjust mixing valve **120** at step **310** by signaling or commanding mixing valve **120** to adjust to the default position. To ensure that mixing valve **120** is in the default position or to monitor mixing valve **120**, controller **134** can receive a signal from position sensor **124** when mixing valve **120** shifts to the default position.

The default position of mixing valve **120** can correspond to a position of mixing valve **120** where the temperature of water within chamber **111** of tank **101** is about the set-point temperature for water within chamber **111** of tank **101** and the temperature of water within mixed water conduit **122** is about the set-point temperature of mixing valve **120** when water is flowing through mixed water conduit **122**. Thus, controller **134** can determine or establish the default position for mixing valve **120** based upon the position of mixing valve **120** when water within chamber **111** of tank **101** is heated by heating elements **103** to about the set-point temperature and the temperature of water flowing through mixed water conduit **122** is about the set-point temperature of mixing valve **120**.

With mixing valve **120** in the default position, controller **134** can receive a temperature measurement from first temperature sensor **130** at step **320**. Based at least in part on the temperature measurement of step **320**, controller **134** can determine whether the temperature of water within mixed water conduit **122** has changed, e.g., dramatically or significantly, at step **330**. The temperature of water within mixed water conduit **122** can increase, e.g., slowly or gradually, due to heat transfer from water within hot water conduit **106** when water is not flowing through mixed water conduit **122**. Similarly, the temperature of water within cold water conduit **104** can increase, e.g., slowly or gradually, due to heat transfer from water within hot water conduit **106** when water is not flowing through mixed water conduit **122**. Conversely, when water begins to flow through mixed water conduit **122**, the temperature of water within mixed water conduit **122** can change, e.g., dramatically or significantly. Thus, if the temperature of water within mixed water conduit **122** changes, e.g., dramatically or significantly, at step **330**, controller **134** can establish or determine that water is flowing through mixed water conduit **122**.

As an example, controller **134** can receive multiple temperature measurements from first temperature sensor **130** at step **320**. In particular, controller **134** can receive a first temperature measurement from first temperature sensor **130**. After receiving the first temperature measurement, controller **134** can also receive a second temperature measurement from first temperature sensor **130**. Based at least in part upon the first and second temperature measurements, controller **134** can determine whether a rate of change of the temperature of water within mixed water conduit **122** is greater than a predetermined value. If the rate of change of the temperature of water within mixed water conduit **122** is greater than the predetermined value, controller **134** can establish that water is flowing through mixed water conduit **122**. In such a manner, controller **134** can establish or determine that water is flowing through mixed water conduit **122** based upon temperature measurements with first temperature sensor **130**. In alternative exemplary embodiments, controller **134** can establish that water is flowing through mixed water conduit **122** if a difference between the first and second temperature measurements is greater than a predetermined value.

After establishing that water is flowing through mixed water conduit **122**, controller **134** can delay for a period of time at step **340**. The period of time can be selected in order to permit the temperature of water within mixed water conduit **122** to approach the set-point temperature of mixing valve **120**. Water within mixed water conduit **122** can experience a large temperature swing after water begins flowing through mixed water conduit **122**. For example, the temperature of water within mixed water conduit **122** can increase rapidly when water starts flowing through mixed water conduit **122** and can decrease and approach the set-point temperature of mixing valve **120** as water continues to flow through mixed water conduit **122**. By delaying for the period of time at step **340**, controller **134** can avoid responding to the predictable temperature increase when water begins flowing through mixed water conduit **122**. Also, mixing valve **120** is in the default position when water begins flowing through mixed water conduit **122** and adjusting mixing valve **120** in response to the predictable temperature increase may be unnecessary.

After establishing that water is flowing through mixed water conduit **122**, controller **134** can receive a temperature measurement from first temperature sensor **130** at step **350**. Based at least in part on the temperature measurement of step **350**, controller **134** can determine whether the temperature of water within mixed water conduit **122** is stable at step **360**. If the temperature of water within mixed water conduit **122** is stable at step **360**, controller **134** can determine or establish that water is continuing to flow through mixed water conduit **122**. Conversely, if the temperature of water within mixed water conduit **122** is unstable at step **360**, controller **134** adjust a position of mixing valve **120** at step **370**.

As an example, controller **134** can receive multiple temperature measurements from first temperature sensor **130** at step **350**. In particular, controller **134** can receive a first temperature measurement from first temperature sensor **130**. After receiving the first temperature measurement, controller **134** can also receive a second temperature measurement from first temperature sensor **130**. Based at least in part upon the first and second temperature measurements, controller **134** can compare a, e.g., absolute, temperature error of mixing valve **120** to a predetermined error threshold. If the temperature error of mixing valve **120** is greater than the predetermined error threshold, controller **134** can establish that the

temperature of water within mixed water conduit **122** is unstable. The temperature error can correspond to a difference between the temperature of water within mixed water conduit **122**, e.g., as measured with first temperature sensor **130**, and the set-point temperature of mixing valve **120**.

Controller **134** adjusts a position of mixing valve **120**, e.g., from the default position, at step **370** if the temperature of water within mixed water conduit **122** is unstable at step **360**. After adjusting the position of mixing valve **120** at step **370**, controller **134** can delay for a period of time at step **380**. The period of time can be selected in order to permit the mixing valve **120** to adjust, e.g., from the default position, and/or to permit account for a lag of first temperature sensor **130**, e.g., between the measured temperature and the true temperature.

At step **390**, controller **134** can receive a temperature measurement from first temperature sensor **130**. Based at least in part on the temperature measurement of step **390**, controller **134** can determine whether the temperature error of mixing valve **120** is decreasing at step **395**. If the temperature error of mixing valve **120** is decreasing at step **395**, controller **134** can determine or establish that water is continuing to flow through mixed water conduit **122**. Conversely, controller **134** can determine or establish that water is not flowing through mixed water conduit **122** if the temperature error of mixing valve **120** is not decreasing at step **395**. Controller **134** can adjust or reset mixing valve **120** to the default position if water is not flowing through mixed water conduit **122** at step **395**.

As discussed above, adjusting the position of mixing valve **120** can adjust the temperature of water within mixed water conduit **122** by adjusting the ratio of relatively cool water flowing into mixed water conduit **122** from cold water conduit **104** and relatively hot water flowing into mixed water conduit **122** from hot water conduit **106**. At step **370**, controller **134** can adjust mixing valve **120** in order to reduce the temperature error of mixing valve **120**. For example, if the temperature of water within mixing conduit **122** is low relative to the set-point temperature of mixing valve **120**, controller **134** can adjust the position of mixing valve **120** in order to direct additional relatively hot water from hot water conduit **106** into mixed water conduit **122** and/or direct less relatively cool water from cold water conduit **104** into mixed water conduit **122**. Conversely, if the temperature of water within mixing conduit **122** is high relative to the set-point temperature of mixing valve **120**, controller **134** can adjust the position of mixing valve **120** in order to direct less relatively hot water from hot water conduit **106** into mixed water conduit **122** and/or direct more relatively cool water from cold water conduit **104** into mixed water conduit **122**.

If water is flowing through mixed water conduit **122**, adjusting the position of mixing valve **120** at step **370** decreases the temperature error of mixing valve **120** at step **395**. Conversely, if water is not flowing through mixed water conduit **122**, adjusting the position of mixing valve **120** at step **370** does not decrease the temperature error of mixing valve **120** at step **395**. Thus, controller **134** can determine or establish that water is continuing to flow through mixed water conduit **122** if the temperature error of mixing valve **120** is decreasing at step **395**, or controller **134** can determine or establish that water is not flowing through mixed water conduit **122** if the temperature error of mixing valve **120** is not decreasing at step **395**. In such a manner, controller **134** can establish or determine whether water is flowing through mixed water conduit **122** based upon temperature measurements with first temperature sensor **130** and the position of mixing valve **120**.

FIG. **4** illustrates an additional method **400** for operating a water heater appliance according to an additional exemplary embodiment of the present subject matter. Method **400** can be used to operate any suitable water heater appliance. For example, method **400** may be utilized to operate water heater appliance **100** (FIG. **1**). Controller **134** of water heater appliance **100** may be programmed to implement method **400**.

Method **400** can be used to determine whether water is flowing through mixed water conduit **122**. In such a manner, method **400** can assist with operating water heater appliance **100**, e.g., by assisting operation of mixing valve **120**. In particular, knowledge of whether water is flowing through mixed water conduit **122** can assist mixing valve **120** with maintaining a proper or predetermined temperature for water within mixed water conduit **122**.

At step **410**, controller **134** sets mixing valve **120** to the default position, e.g., when water is not flowing through mixing valve **120** and/or mixed water conduit **122**. At step **420**, controller **134** receives a first temperature measurement from first temperature sensor **130**. At step **430**, controller **134** receives a second temperature measurement from first temperature sensor **130**. Controller **134** can establish that water is flowing through mixing valve **120** and/or mixed water conduit **122** at step **440** if a difference between the first and second temperature measurements is greater than a predetermined value. In alternative exemplary embodiments, controller **134** can establish that water is flowing through mixing valve **120** and/or mixed water conduit **122** at step **440** if a rate of change for water within mixed water conduit **122** is greater than a predetermined value. The rate of change for water within mixed water conduit **122** can be established with the first temperature measurement from step **420** and the second temperature measurement from step **430**.

Method **400** can also include receiving a first temperature measurement from second temperature sensor **132** and receiving a second temperature measurement from second temperature sensor **132**. Controller **132** can establish that water is not flowing through mixing valve **120** and/or mixed water conduit **122** if the second temperature measurement from second temperature sensor **132** is greater than the first temperature measurement from second temperature sensor **132**.

Second temperature sensor **132** is positioned proximate cold water conduit **104** and, e.g., mixing valve **120**. If water is not flowing through cold water conduit **104**, water within cold water conduit **104** can increase in temperature due to heat transfer from water within hot water conduit **106**. Thus, if water within cold water conduit **104** is increasing in temperature, controller **134** can establish that water is not flowing through mixing valve **120** and/or mixed water conduit **122**.

FIG. **5** illustrates another method **500** for operating a water heater appliance according to another exemplary embodiment of the present subject matter. Method **500** can be used to operate any suitable water heater appliance. For example, method **500** may be utilized to operate water heater appliance **100** (FIG. **1**). Controller **134** of water heater appliance **100** may be programmed to implement method **500**.

Method **500** can be used to determine whether water is flowing through mixed water conduit **122**. In such a manner, method **500** can assist with operating water heater appliance **100**, e.g., by assisting operation of mixing valve **120**. In particular, knowledge of whether water is flowing through mixed water conduit **122** can assist mixing valve **120** with maintaining a proper or predetermined temperature for water within mixed water conduit **122**.

At step **510**, controller **134** receives a first temperature measurement from first temperature sensor **130**. At step **520**, controller **134** receives a second temperature measurement from first temperature sensor **130**. Controller **134** determines

whether the temperature of water within the mixed water conduit **122** is stable based at least in part on the first and second temperature measurements at step **530**. If the temperature of water within the mixed water conduit **122** is unstable, controller **134** adjusts the position of mixing valve **120** at step **540**. At step **550**, controller **134** receives an additional temperature measurement from first temperature sensor **130**. Based at least in part on the additional temperature measurement, controller **134** determines whether a difference between the temperature of water within mixed water conduit **122** and the set-point temperature of mixing valve **120** is decreasing. If the difference between the temperature of water within mixed water conduit **122** and the set-point temperature of mixing valve **120** is not decreasing, controller **134** establishes that water is not flowing through mixed water conduit **122**.

It should be understood that in alternative exemplary embodiments, water heater appliance **100** need not include mixed water conduit **122**. In such exemplary embodiments, mixing valve **120** can direct water into hot water conduit **106** in order to regulate a temperature of water within hot water conduit **106**.

This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. A method for operating a water heater appliance, the water heater appliance having a tank and a heating element for heating water within the tank, the water heater appliance also having a cold water conduit for directing a flow of water into the tank and a hot water conduit for directing water out of the tank, the water heater appliance further having a mixing valve, the mixing valve configured for regulating a temperature of water within the hot water conduit by selectively directing a flow of relatively cool water into the hot water conduit, the water heater appliance also having a temperature sensor positioned downstream of the mixing valve for measuring a temperature of water within the hot water conduit, the method comprising:

setting the mixing valve of the water heater appliance to a default position when water is not flowing through the hot water conduit of the water heater appliance;

receiving a first temperature measurement from the temperature sensor of the water heater appliance when water is not flowing through the hot water conduit of the water heater appliance;

receiving a second temperature measurement from the temperature sensor of the water heater appliance after said step of receiving the first temperature measurement;

determining whether a rate of change of the temperature of water within the hot water conduit is greater than a predetermined value based at least in part on the first and second temperature measurements; and

establishing that water is flowing through the hot water conduit of the water heater appliance at said step of receiving the second temperature measurement if the rate of change of the temperature of water within the hot water conduit is greater than the predetermined value at said step of determining whether the rate of change of the temperature of water within the hot water conduit is greater than the predetermined value.

2. The method of claim **1**, wherein the default position of the mixing valve corresponds to a position of the mixing valve where a temperature of water within the tank of the water heater appliance is about a set-point temperature for water within the tank of the water heater appliance and the temperature of water within the hot water conduit of the water heater appliance is about a set-point temperature of the mixing valve when water is flowing through the hot water conduit of the water heater appliance.

3. The method of claim **1**, further comprising:

receiving an additional temperature measurement from the temperature sensor of the water heater appliance after said step of establishing that water is flowing through the hot water conduit of the water heater appliance;

determining whether the temperature of water within the hot water conduit is unstable based at least in part on the additional temperature measurement of said step of receiving the additional temperature measurement; and

adjusting the mixing valve of the water heater appliance from the default position if the temperature of water within the hot water conduit is unstable at said step of determining whether the temperature of water within the hot water conduit is unstable.

4. The method of claim **3**, wherein said step of determining whether the temperature of water within the hot water conduit is unstable comprises:

comparing a temperature error of the mixing valve to a predetermined error threshold; and

determining that the temperature of water within the hot water conduit is unstable if the temperature error of the mixing valve is greater than the predetermined error threshold.

5. The method of claim **3**, further comprising delaying for a period of time between said step of establishing that water is flowing through the hot water conduit of the water heater appliance and said step of receiving the additional temperature measurement.

6. The method of claim **5**, wherein the period of time is selected in order to permit the temperature of water within the hot water conduit to approach a set-point temperature of the mixing valve.

7. The method of claim **5**, further comprising resetting the mixing valve of the water heater appliance to the default position after said step of establishing that water is not flowing through the hot water conduit of the water heater appliance.

8. The method of claim **7**, wherein the period of time is selected in order to permit the mixing valve to adjust at said step of adjusting the mixing valve of the water heater appliance and to permit the temperature sensor to change temperature.

9. The method of claim **5**, further comprising delaying for a period of time between said step of adjusting the mixing valve of the water heater appliance from the default position and said step of receiving the another temperature measurement.

10. The method of claim **3**, further comprising:

receiving another temperature measurement from the temperature sensor of the water heater appliance after said step of adjusting;

determining whether a difference between the temperature of water within the hot water conduit and a set-point temperature of the mixing valve is decreasing based at

least in part on the another temperature measurement of said step of receiving the another temperature measurement; and

establishing that water is not flowing through the hot water conduit of the water heater appliance if the difference between the temperature of water within the hot water conduit and the set-point temperature of the mixing valve is not decreasing at said step of determining whether the difference between the temperature of water within the hot water conduit and the set-point temperature of the mixing valve is decreasing.

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